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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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7590 11/17/2004 Winstead Sechrest & Minick P.C. 5400 Renaissance Tower Dallas, TX 75270-2199			EXAMINER TSOY, ELENA	
			ART UNIT 1762	PAPER NUMBER

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/935,493

Applicant(s)

SMALLEY ET AL.

Examiner

Elena Tsoy

Art Unit

1762

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 10/18/2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 11-15, 17-27 and 47-86 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 25, 26 and 76 is/are allowed.
- 6) ☒ Claim(s) 11-15, 17-24, 27, 47-75 and 86 is/are rejected.
- 7) ☒ Claim(s) 77-85 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 6/14/04.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

Response to Amendment

1. Amendment filed on October 18, 2004 has been entered. New claims 77-86 have been added. Claims 11-15, 17-27, 47-86 are pending in the application.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

- (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
- (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
- (c) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Rejection of claims 11, 12, 14, 15, 18, 19, 47 under 35 U.S.C. 103(a) as being unpatentable over Kuper (US 2002/0092613) in view of Shaffer et al (Advanced materials, 11, No. 11, 1999) has been withdrawn due to the date.
5. Rejection of claims 20, 22 under 35 U.S.C. 102(b) as being anticipated by Riggs et al (JACS, 2000, 122, 5879-5880) has been withdrawn.

6. Rejection of claims 21, 23 under 35 U.S.C. 103(a) as being unpatentable over Riggs et al (JACS, 2000, 122, 5879-5880) has been withdrawn.
7. **Claims 11, 15, 17** stand rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Uchida et al (US 5,560,898) for the reasons of record as set forth in Paragraph No. 6 of the Office Action mailed on April 20, 2004.
8. **Claims 20-23, 49-54, 66, 75** stand rejected under 35 U.S.C. 103(a) as being unpatentable over Shaffer et al (Advanced materials, 11, No. 11, 1999) in view of Tohji et al (Fullerene Science and Technology, 7(4), 665-679, 1999) for the reasons of record as set forth in Paragraph No. 11 of the Office Action mailed on April 20, 2004.
9. **Claim 27** stands rejected under 35 U.S.C. 103(a) as being unpatentable over Shaffer et al (Advanced materials, 11, No. 11, 1999), in view of Bower et al (EP 989579) for the reasons of record as set forth in Paragraph No. 14 of the Office Action mailed on April 20, 2004.
10. **Claims 58, 69** stand rejected under 35 U.S.C. 103(a) as being unpatentable over Shaffer et al (Advanced materials, 11, No. 11, 1999) in view of Tohji et al (Fullerene Science and Technology, 7(4), 665-679, 1999) for the reasons of record as set forth in Paragraph No. 16 of the Office Action mailed on April 20, 2004.
11. **Claims 65, 74** stand rejected under 35 U.S.C. 103(a) as being unpatentable over Shaffer et al (Advanced materials, 11, No. 11, 1999) in view of Tohji et al (Fullerene Science and Technology, 7(4), 665-679, 1999), further in view of Bower et al (EP 989579) for the reasons of record as set forth in Paragraph No. 18 of the Office Action mailed on April 20, 2004.

12. **Claims 11, 15, 47** are rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Shaffer et al (Advanced materials, 11, No. 11, 1999).

Shaffer et al disclose a method for making polymer-coated carbon nanotubes comprising mixing aqueous solution of PVOH polymer solution with catalytically grown carbon nanotubes (See page 937, paragraph 2) followed by casting and controlled water evaporation (See page 938, paragraph 2) so that to cover the nanotube with an adsorbed layer of the polymer (See page 938, paragraph 3).

The Examiner's Note: it is well known in the art that any existing techniques contain both MWNTs and SWNTs.

13. **Claims 11-15, 17-19, 24, 48, 86** are rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529).

Davey et al disclose a process for making polymer wrapped (coated) carbon nanotubes comprising the steps of adding nanotube soot to a solvent which includes a nanotube extracting polymers having coiling structure (See column 3, lines 45-46) such as poly(m-phenylene-co-2,5-dioctoxy-p-phenylenevinylene), poly(dioctyl fluorene) or polysulphonic acid (surfactant) (See column 3, lines 25-32) to form a solution (i.e. polymer and nanotubes are added sequentially); mixing the solution to form a nanotube composite suspension while allowing the undesirable solid materials such as amorphous carbon to settle out (i.e. wrapped carbon nanotubes are substantially free of amorphous carbon) (See column 3, lines 42-46); removing the nanotube composite suspension (See column 3, lines 33-61). Conveniently, the solution is mixed by sonication using ultrasonic bath, but any other suitable mixing method may be used (See column

3, lines 62-63). Any suitable solvent which can solubilise the nanotube extracting material can be used (See column 3, lines 55-57). The polymer-coated carbon nanotubes can be blended with other plastics (See column 8, lines 12-13) in injection moulding (See column 8, line 12).

Davey et al teach that the term *nanotube* is taken to mean **any nanostructure and related materials**. The nanotubes which are mixed with polymers can be in the form of carbon nanotubes, nanotubes of other materials such as vanadium pentoxide for example, nanostructures (regular and undefined), as well as derivatives of these which can be based on or contain, as an example, Silicon, Boron, Tin, nitrogen, compounds of vanadium and oxygen such as vanadium pentoxide, etc. The nanostructures can have dimensions from nanometers in length to millimeters in length, as well as nanometers in width to micrometers in width. See column 3, lines 8-23. In other words, nanostructures having differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, chemical reactivity and chemical stability can be wrapped by the method.

It is the Examiner's position that a suitable solvent, which can solubilise the poly(sulphonic acid) polymer is water.

Davey et al fail to teach that carbon nanotubes include SWNTs that are substantially free of amorphous carbon so that SWNT can also be wrapped using the method (Claims 11, 12); SWNTs are coated with at least two polymers (Claims 13, 48); the polymer and the plurality of individual SWNTs are added to the solvent simultaneously (Claim 15); the concentration of SWNTs in the solvent is between about 0.1 grams/liter and about 5 grams/liter (Claim 18); the concentration of polymer in the solvent is between about 1.0 percent and about 5.0 percent by weight (Claim 19).

Dillon et al teach that purified SWNTs free of amorphous carbon form bundles in a solvent (See PP 43, 47), but can be dissociated and dispersed in aqueous solution with the use of surfactants *or* with the use of sonication (See P46).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used SWNTs, including purified SWNTs free of amorphous carbon as carbon nanotubes, in Davey et al with the expectation of providing the desired wrapped SWNTs, since Davey et al teach that nanotubes of any nanostructure can be wrapped using the method, and Dillon et al teach that bundles of purified SWNTs free of amorphous carbon can be dissociated and dispersed in aqueous solution with the use of surfactants *or* with the use of sonication.

As to claims 13, 48, it is held that it is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose. In re Kerkhoven, 626 F.2d 846, 850, 205 USPQ 1069, 1072 (CCPA 1980). See also In re Crockett, 279 F.2d 274, 126 USPQ 186 (CCPA 1960); and Ex parte Quadranti, 25 USPQ2d 1071 (Bd. Pat. App. & Inter. 1992).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined at least two polymers as extracting material in a method of Davey et al in view of Dillon et al with the expectation of providing the desired wrapped carbon nanotubes since it is held that it is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose.

As to claim 15, it is held that sequence of adding ingredients is obvious absent a showing of criticality. In re Gibson 5 USPQ 231, 232 (CCPA 1930).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have added a polymer and SWNTs in a method of Davey et al in view of Dillon et al simultaneously to water since it is held that sequence of adding ingredients is obvious absent a showing of criticality.

As to claims 18, 19, it is held that concentration limitations are obvious absent a showing of criticality. Akzo v. E.I. du Pont de Nemours 1 USPQ 2d 1704 (Fed. Cir. 1987).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have determined the optimum values of the relevant concentration parameters (including those of claims 18, 19) in a method of Davey et al in view of Dillon et al through routine experimentation in the absence of a showing of criticality.

14. **Claims 20-23, 49-54, 56-58, 60-64, 67-69, 71-73** are rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Tohji et al (Fullerene Science and Technology, 7(4), 665-679, 1999).

Davey et al in view of Dillon et al, as applied above, fail to teach that solvent is heated to a temperature at least 40 °C (Claims 20, 49) or between about 50°C and about 60°C (Claims 51, 21) for 0.1-100 hours (Claims 22, 23, 50, 53, 62) or for 1-50 hours (Claims 52, 54, 63); the concentration of SWNT in the solvent is 0.1-5.0 grams/liter (Claims 60, 71); the concentration of polymer in the solvent is 0.1-5.0 wt % (Claims 61, 72).

Tohji et al teach that treating soot containing fullerenes including SWNTs with boiling water untangles the fullerenes from the soot (See page 666, P2; page 672, P2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have heated solvent (e.g. water) containing carbon nanotubes such as SWNTs with

accompanying soot and a polymer in Davey et al in view of Dillon et al with the expectation of providing the desired improved separation of the carbon nanotubes from the soot, since Tohji et al teach that treating fullerene soot with boiling water untangles the fullerenes such as SWNT from the soot.

As to the temperature and time, one of ordinary skill in the art at would know that effect of heat treating depends on temperature and time of treating so that the same result as treating at high temperature and short period of time can be achieved at lower temperature but for longer time.

In other words, time and temperature are result effective parameters in a heating process.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have determined the optimum values of the relevant temperature and time parameters (including those of claimed invention) in a method of Davey et al in view of Dillon et al in view of Tohji et al through routine experimentation in the absence of a showing of criticality.

15. **Claim 27** is rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Bower et al (EP 989579).

Davey et al in view of Dillon et al, as applied above, fail to teach that the method further comprises the step of aligning the nanotubes by application of an external field selected from the group consisting of an electrical field, a magnetic field and a shear flow field.

Bower et al teach that a mixture of carbon nanotubes such as SWNT and/or MWNT (See column 6, lines 7-10) and polymers in solvents in the form of a solution or slurry (See column 9,

lines 38-40), applied to a substrate can be aligned by application of magnetic and/or electric fields in order to reduce the overall energy of the system (See claim 15; column 10, lines 18-43, 56).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have aligned polymer-coated nanotubes in Davey et al in view of Dillon et al by application of an external magnetic and/or electric fields with the expectation of providing the desired reduced overall energy of the system since Bower et al teach that a mixture of SWNT and/or MWNT and polymers applied to a substrate can be aligned by application magnetic and/or electric fields in order to reduce the overall energy of the system.

16. **Claim 47** is rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Shaffer et al (Advanced materials, 11, No. 11, 1999).

Davey et al, as applied above, further teach that any polymer preferably of coiling structure can be used for wrapping carbon nanotubes (See column 3, lines 1-7). However, Davey et al/in view of Dillon et al fail to teach that the polymer is polyvinyl alcohol.

Shaffer et al teach that polyvinyl alcohol can be used for covering carbon nanotubes in water by mixing (See page 938, P3).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used polyvinyl alcohol as a polymer in Davey et al in view of Dillon et al since Shaffer et al disclose polyvinyl alcohol is suitable for covering carbon nanotubes in water by mixing.

It is held that the selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945). See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960) (selection of a known plastic to make a container of a type made of plastics prior to the invention was held to be obvious); *Ryco, Inc. v. Ag-Bag Corp.*, 857 F.2d 1418, 8 USPQ2d 1323 (Fed. Cir. 1988).

17. **Claim 55** is rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Hsu et al (US 6,333,598).

Davey et al in view of Dillon et al are applied here for the same reasons as above. Davey et al in view of Dillon et al fail to teach that the solvent further comprises a surfactant such as sodium dodecyl sulfate.

Hsu et al teach that carbon nanotubes can be treated with a micellar surfactant such as sodium dodecylsulfate (SDS), which attach to the nanotube in a shell, to provide negatively-charged end groups that project outward to the water phase, which end groups will preferentially attach to a hydrophobic (e.g., octadecanethiol-coated noble metal) surface but would not attach to negatively charged surfaces (See column 15, lines 5-19).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have added sodium dodecylsulfate to the solvent in a method of Davey et al in view of Dillon et al with the expectation of providing the desired attachment to hydrophobic (e.g., octadecanethiol-coated noble metal) surface, and not to negatively charged surfaces depending on particular application, as taught by Hsu et al.

18. **Claims 59, 70** are rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Tohji et al (Fullerene Science and Technology, 7(4), 665-679, 1999), and further in view of Hsu et al (US 6,333,598).

Davey et al in view of Dillon et al in view of Tohji et al are applied here for the same reasons as above. Davey et al in view of Dillon et al in view of Tohji et al fail to teach that the surfactant is sodium dodecyl sulfate.

Hsu et al are applied here for the same reasons as above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have added sodium dodecylsulfate to the solvent in a method of Davey et al in view of Dillon et al in view of Tohji et al with the expectation of providing the desired attachment to hydrophobic (e.g., octadecanethiol-coated noble metal) surface, and not to negatively charged surfaces depending on particular application, as taught by Hsu et al.

19. **Claims 65, 74** are rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Tohji et al (Fullerene Science and Technology, 7(4), 665-679, 1999), and further in view of Bower et al (EP 989579).

Davey et al in view of Dillon et al in view of Tohji et al are applied here for the same reasons as above. Davey et al in view of Dillon et al in view of Tohji et al fail to teach that the method further comprises the step of aligning the nanotubes by application of an external field selected from the group consisting of an electrical field, a magnetic field and a shear flow field.

Bower et al are applied here for the same reasons as above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have aligned polymer-coated nanotubes in Davey et al in view of Dillon et al in view of Tohji et al by application of an external magnetic and/or electric fields with the expectation of providing the desired reduced overall energy of the system since Bower et al teach that a mixture of SWNT and/or MWNT and polymers applied to a substrate can be aligned by application magnetic and/or electric fields in order to reduce the overall energy of the system.

20. **Claims 66, 75** are rejected under 35 U.S.C. 103(a) as being unpatentable over Davey et al (US 6,576,341) in view of Dillon et al (US 20020150529), further in view of Shaffer et al (Advanced materials, 11, No. 11, 1999).

Davey et al in view of Dillon et al in view of Tohji et al are applied here for the same reasons as above. Davey et al in view of Dillon et al in view of Tohji et al fail to teach that the polymer is polyvinyl alcohol.

Shaffer et al teach that polyvinyl alcohol can be used for covering carbon nanotubes in water by mixing (See page 938, P3).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used polyvinyl alcohol as a polymer in Davey et al in view of Dillon et al in view of Tohji et al since Shaffer et al disclose polyvinyl alcohol is suitable for covering carbon nanotubes in water by mixing.

21. **Claim 86** is rejected under 35 U.S.C. 103(a) as being unpatentable over Curran et al (Advanced Materials, 1998, 10, No. 14, pages 1091-1093) in view of Coleman et al (Physical Review B, v. 58, No. 12, 1998, pages R7492-R7495).

Curran et al disclose a method for making conjugated-PMPV/multiwalled carbon-nanotube composite, wherein multiwalled carbon-nanotube (prepared by the arc discharge) and PMPV polymer are mixed together in toluene and briefly sonicated. Curran et al teach that PMPV polymer tends to coil so that when PMPV polymer and nanotube powder are mixed together in toluene and briefly sonicated, the coiled polymer wraps around the nanotubes and keep them in solution indefinitely (See page 1091, column 1 and column 2, paragraph 2).

Curran et al fail to teach that the method can be used for wrapping SWNT.

Coleman et al teach that nanotube powder (prepared in Kratschmer generator) consisting of **one** (SWNT) or **more** (MWNT) sheets of graphene wrapped around each other (See page R7492, column 1) can be also conjugated with PMPV by mixing the powder with PMPV polymer in toluene and briefly sonicating (See page R7492, column 2). Coleman et al teach that it is well known that the soot produced in Kratschmer generator contains amorphous carbon, graphitic nanoparticles and carbon nanotubes. In other words, Coleman et al teach that both SWNT or MWNT (having any number of layers) can be wrapped with PMPV.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used a method of Curran et al to conjugate SWNT so that to suspend it in a toluene indefinitely since Coleman et al teach that both SWNT or MWNT (having any number of layers) can be wrapped with PMPV.

22. The prior art made of record and not relied upon is considered pertinent to applicant disclosure.

Scott et al (US 6,623,337) teaches that polysulfonic acid is surfactant (See column 6, lines 26-27).

Horiuchi et al (US 6,712,864) teach that it is well known in the art that techniques for producing carbon nanotubes with identical structure are not yet achieved (See column 2, lines 1-3).

Allowable Subject Matter

23. **Claims 25, 26, 76** are allowed for the reasons of record as set forth in Paragraph No. 19 of the Office Action mailed on April 20, 2004.

Claims 77-85 are objected to as being dependent upon a rejected base claims 11 and 20, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

24. Applicants' arguments filed October 18, 2004 have been fully considered but they are not persuasive.

(A) Applicants argue that: (i) Shaffer teaches the use of multi-wall carbon nanotubes, as per the source (Hyperion Catalysis International, see Shaffer, footnote page 937) and per the statement: "It is not yet clear whether this result is chiefly a consequence of the imperfection in the graphite layers within the catalytically grown nanotubes used, or whether it relates to a fundamental difficulty of shear stress transfer between the shells of multi-wall carbon nanotubes" (Shaffer, page 939, col. 2, ll. 7-11); (ii) multi-wall carbon nanotubes are

fundamentally different from single-wall carbon nanotubes, since single-wall carbon nanotubes have only a single layer of sp^2 – hybridized carbon atoms generally arranged in hexagons and pentagons while multi-wall carbon nanotubes are composed of multiple, cylindrical concentric carbon layers arranged in a nested fashion. Single-wall carbon nanotubes “rope” together and are held tightly by van der Waals forces. As such, single-wall nanotubes are difficult to separate and disperse in other media, while multi-wall nanotubes **generally do not rope** and, as such, are readily separable and dispersible. The structural differences between single-wall and multi-wall carbon nanotubes also leads to differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, chemical reactivity and chemical stability.

The Examiner respectfully disagrees with this argument. As to (i), Clearly, Shaffer does not limit his teaching to MWNTs only since Shaffer teaches: “Therefore, in this work, **catalytically grown nanotubes** have been used as a **starting material**, despite a higher defect concentration. The starting material was long and entangled, although free from contaminating nanoparticles” (See page 938, column 1, lines 1-5). Moreover, it is well known in the art that techniques specifically designed for producing MWNT still produce minor amounts of SWNT (See for example, US 6,712,864 to Horiuchi et al, column 2, lines 1-3). Since Shaffe does not teach that MWNT were separated from catalytically grown nanotubes and purified, one can reasonably assume that **catalytically grown nanotubes** include both MWNT and SWNT. As to (ii), all layers of MWNT including an outermost layer also have sp^2 – hybridized carbon atoms generally arranged in hexagons and pentagons, i.e. the outermost layer of MWNT is substantially identical to SWNT. Therefore, the surface of MWNT should have *chemical*

properties substantially identical to that of SWNT. The only *fundamental* difference between SWNT and MWNT is flexibility as was discussed by Shaffer (See page 939, column 2, paragraph 1), and SWNT aggregate more easily. However, Shaffer teaches that *careful mixing* of the components prevents **aggregation** (not limiting to aggregation of MWNT) (See page 938, column 1, paragraph 3). Therefore, clearly a method of Shaffer can be used for any nanotubes.

(B) Applicants argue that Uchida does not teach single-wall carbon nanotubes. Rather, Uchida teaches purification of multi-wall carbon nanotubes formed by the method of Ebbesen. Uchida states: "One method for the preparation of carbon nanotubes is disclosed by Ebbesen et al. (Nature, 358, 220(1992))". Uchida, col. 1, 11.13-15. Uchida further states: "Such a raw material mixture may be obtained by the method disclosed in the above Ebbesen et al article." Uchida, col. 2, 11. 1-3.

The Examiner respectfully disagrees with this argument. In contrast to Applicants' argument, Uchida teaches: "This invention relates to a process for the isolation of carbon nanotubes from a *mixture* containing **carbon nanotubes** and graphite particles". It is well known in the art that "carbon nanotubes" include both MWNT and SWNT. It is clear from a context of Uchida that a method of Ebbesen et al is only one of many other methods of making carbon nanotubes. Uchida teaches that a raw material is a mixture containing carbon nanotubes having a length of 1 micron or more and a diameter of 50 nm or **less** and graphite particles (See column 1, lines 65-67). Such. Uchida expressly teaches that a raw material mixture may be obtained by the method of Ebbesen et al article where generally, the content of the carbon nanotubes in the raw material mixture is at most about 5% by weight, but the process of the

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present invention is effective for a raw material mixture having a carbon nanotube content of more than, for example, 50% by weight. (See column 2, lines 1-10).

Moreover, nowhere Uchida states that the method is applicable to MWNT only. In example 1 of Uchida, a **crude** carbon nanotube product (i.e. both MWNT and SWNT) was ground in a mortar and sonicated in ethanol for 60 minutes to remove graphite particles (See example 1 and column 1, lines 15-18).

Conclusion

25. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Elena Tsoy whose telephone number is (571) 272-1429. The examiner can normally be reached on Mo-Thur. 9:00-7:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (571) 272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Elena Tsoy
Primary Examiner
Art Unit 1762

November 10, 2004

ELENA TSOY
PRIMARY EXAMINER

